

CLAIMS

1. Plate heat exchanger (1) device advantageously intended for use with a gas turbine, comprising a number of corrugated plates (2), each one with a first edge part (3) with an opposing second edge part (4), a third edge part (5) with an opposing fourth edge part (6), where the first and second flow channels (7, 8) are arranged between the corrugated plates (2), where every second flow channels are arranged to have a through flow of a heat-emitting medium (9) and every other second are arranged to have a through flow of a heat absorbing medium (10), the first flow channels for one of the mediums, advantageously the heat absorbing medium (10) are, via first inlet openings (11) and first outlet openings (12) respectively, connected essentially parallel to in- and outgoing junction channels (13, 14) for said heat absorbing medium (10), **characterised in** that the plates (2) are fitted to each other in pairs, forming cells (15) comprising an inner spacing element (16) welded to and in-between the plates, where the inner spacing element (16) extends along the edge parts (3-6) with interruption for the first inlet opening (11) and the first outlet opening (13) for one of the mediums, advantageously the heat-absorbing medium (10), where outer spacing elements (17) are welded to the plates (2) on the sides of the plates (2) facing away from each other, along at least two of the edge parts (3-6), the cells (15) are stacked against each other and joint together by welding via the outer spacing elements (17), and said in- and outgoing junction channels (13, 14) are welded to said first inlet opening (11) and first outlet opening (12) respectively.
2. Plate heat exchanger (1) device according to claim 1, **characterised in** that the first outlet opening (12) is wider than the first inlet opening (11).
3. Plate heat exchanger (1) device according to claim 2, **characterised in** that the inner spacing element (16) of the cell (15) consists of a first inner spacing element (18) along the first edge part (3) and the fourth edge part (6) and a second inner spacing element (19) along the second edge part (4) and

the third edge part (5), the first inner spacing element (18) has a first end section (20) thinner than the rest of the first spacing element (18), where the first end section (20) is pleated along the extension of the first inlet opening (11), and the second inner spacing element (19) has a second end section (21) thinner than the rest of the second spacing element (19), where the second end section (21) is pleated along the extension of the first outlet opening (12).

4. Plate heat exchanger (1) device according to claim 3, **characterised in** that each of the pleated end sections (20, 21) of the first and second inner spacing elements (18, 19), has a first and a second pleating height respectively (22, 23), which allows the pleated end sections (20, 21) to act as spacing elements in the first inlet opening (11) and the first outlet opening (12) respectively.

5. Plate heat exchanger (1) device according to claim 4, **characterised in** that the corrugated plates (2) are divided into first plates (24) with a first side (25) and a second side (26), corrugated with a first pattern (27), and second plates (28) with a third side (29) and a fourth side (30) corrugated with a second pattern (31), the first and second plates (24, 28) are assembled in pairs with the second side (26) towards the third side (29).

6. Plate heat exchanger (1) device according to claim 5, **characterised in** that the first plates (24) are corrugated in such a way that each of the first plates has first depressions (32) and first ridges (33) on the first side, and correspondingly second depressions (34) and second ridges (35) on the second side (26), diagonally from the third edge part (5) to the fourth edge part (6), with the first and the fourth edge part (3, 6) constituting catheti in an imaginary triangle with the diagonal first depressions (32) as hypotenuse, the second plates (28) are corrugated in such a way that each of the second plates (28) has third depressions (36) and third ridges (37) on the third side (29), and correspondingly fourth depressions (38) and fourth ridges (39) on

the fourth side (30), diagonally from the fourth edge part (6) to the third edge part (5), with the first and third edge parts (3, 5) constituting catheti in an imaginary triangle with the diagonal third depressions (36) as hypotenuse.

5 7. Plate heat exchanger (1) device according to claim 6, **characterised in**
that the depth of the first and fourth depressions (32, 38) respectively varies
in such a way that a first inlet triangle (40) and a first outlet triangle (41) with
a first depth (49) on the first depressions (32) are formed in the first plate
(24), and a second inlet triangle (42) and a second outlet triangle (43) with a
10 second depth of the fourth depressions (38) are formed in the second plate (28)
each of the first and second inlet triangles (40, 42) has a feature in the shape
of a triangle at the respective plates (24, 28), with an imaginary cathetus
along the first edge part (3) with a length corresponding to the first inlet
opening (11), an imaginary cathetus in the third end part (5) and a
15 hypotenuse from the first edge part (3) to the second edge part (4), where
each of the first and second outlet triangles (41, 43) has the shape of an
imaginary cathetus along the second edge part (4) with a length
corresponding to the first outlet opening (12), an imaginary cathetus in the
fourth edge part (6) and an imaginary hypotenuse from the second edge part
20 (4) to the first edge part (3), and the first plate also has a first diagonal
section (44) with a third depth (50) of the first depressions (32), the second
plate (28) has a second diagonal section (45) with a fourth depth of the fourth
depressions (38) the diagonal sections (44, 45) are formed diagonally over
each of the plates (24, 28) between the inlet triangles and outlet triangles
25 respectively.

8. Plate heat exchanger (1) device according to claim 7, **characterised in**
that at each of the first and second plates, the first inlet triangle (40) and the
second inlet triangle (42) have the same geometrical shape, and the first
30 diagonal section (44) and the second diagonal section (45) have the same
geometrical shape, and the first outlet triangle (41) and the second outlet
triangle (43) have the same geometrical shape.

9. Plate heat exchanger (1) device according to claim 8, **characterised in** that the cells (15) consist of the first and second plates (24, 28) joint in pairs with the second and third sides (26, 29) placed towards each other, wherein
5 the second ridges (35) form an angle with the third ridges (37), and where the first and second inlet triangles (40, 42) form a first cross-stream section (46), and where the first and second outlet triangles (41, 43) form a second cross-stream section (47), and where the first and second diagonal sections (44, 45) form a counter-stream section (48).
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10. Plate heat exchanger (1) device according to claim 9, **characterised in** that the second ridges (35) are in contact with the third ridges (37) in the first points of intersection at that part of the cell (15) that is formed by the diagonal sections (44, 45) of the plates (24, 28).
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11. Plate heat exchanger (1) device according to claim 10, **characterised in** that the cells (15) are stacked against each other with the first and fourth sides (25, 30) of the plates (24, 28) towards each other.
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12. Plate heat exchanger (1) device according to claim 11, **characterised in** that the first ridges (33) form an angle to the fourth ridges (39) when the cells (15) are stacked, and additionally the first ridges (33) are in contact with the fourth ridges (39) in the second points of intersection.
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13. Plate heat exchanger (1) device according to claim 12, **characterised in** that the thickness of said outer spacing element (17) is such that the upper edge of the outer spacing elements (17) is in alignment with the first ridges (33) on the first side (25) and is in alignment with the fourth ridges (39) on the fourth side (30)
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14. Plate heat exchanger (1) device according to claim 13, **characterised in** that the thickness of said outer spacing element (17) is essentially twice the thickness of the inner spacing element.
- 5 15. Plate heat exchanger (1) device according to claim 14, **characterised in** that additional in- and outgoing junction channels (55, 56) are welded to the recuperator, parallel to the in- and outgoing junction channels (13, 14), on the opposite side of the recuperator sides formed by the cells (15), where the in- and outgoing junction channels (13, 14) are welded to the sides.
- 10 16. Plate heat exchanger (1) device according to claim 15, **characterised in** that the additional inlet and outlet openings (57, 58) are arranged in the cell (15) on that distance that form the width of the respective longitudinal openings of the in- and outgoing junction channels (55, 56).
- 15 17. Plate heat exchanger (1) device according to any one of the previous claims, **characterised in** that said welding refers to laser welding.
- 20 18. Method for manufacturing a heat exchanger (1) device advantageously intended for use with a gas turbine, wherein a number of corrugated plates (2), each and one with a first edge part (3) with an opposing second edge part (4), a third edge part (5) with an opposing fourth edge part (6), are arranged in such a way that first and second flow channels (7, 8) are arranged between the corrugated plates (2), where every second flow
- 25 channels are arranged to have a through flow of a heat-emitting medium (9) and every other second are arranged to have a through flow of a heat absorbing medium (10), the first flow channels (7) for one of the mediums, advantageously the heat absorbing medium (10), are brought to parallel communication with in- and outgoing junction channels (13, 14) respectively,
- 30 via first inlet openings (11) and first outlet openings (12), for said one of the mediums, **characterised in** that:
- cells (15) are formed by;

- an inner spacing element (16) being welded between two plates (2), where the inner spacing element (16) extends along the edge parts (3-6) with interruptions for the first inlet openings (11) and the first outlet openings (12);
 - 5 -an outer spacing element (17) being welded to the plates (2) on the sides of the plates (2) facing away from each other, along at least two of the edge parts (3-6);
 - the two previous steps are repeated until a predetermined number of cells (15) have been produced for one of the mediums, preferably the heat absorbing medium (10);
 - 10 - cells (15) are successively stacked against each other in such a way that the outer spacing elements (17) are in direct contact with each other between the cells;
 - the outer spacing elements (17) are welded together in such a way that the
 - 15 cells form a coherent package where the distance between the cells form second flow channels (8) for the second medium (9); and
 - said in- and outgoing junction channels (13, 14) are welded to said first inlet opening (22) and first outlet opening (12) respectively.
- 20 19. Method for manufacturing a plate heat exchanger (1) device according to claim 18, **characterised in that**;
- two gas tight end covers are welded to short ends of the in- and outgoing junction channels (13, 14), where each of the end covers are welded also to the plates (2) that are placed on the short sides of the recuperator.
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20. Method for manufacturing a plate heat exchanger (1) device according to claim 19, **characterised in that**;
- the inner spacing element (16) of the cell (12) consists of a first inner spacing element (18) along the first edge part (3) and the fourth edge part
 - 30 (6), with a first end section (20) thinner than the rest of the first spacing element (18), where the first end section (20) is pleated along the extension of the first inlet opening (11); and

-a second inner spacing element (19) along the second edge part (4) and the third edge part (5), with a second end section (21) thinner than the rest of the second spacing element (19), where the second end section (21) is pleated along the extension of the first outlet opening (12).

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21. Method for manufacturing a plate heat exchanger (1) device according to claim 20, **characterised in** that said welding is done by laser welding.

22. Method for manufacturing a plate heat exchanger (1) device according to
10 claim 21, **characterised in** that the plates are made mainly rectangular and that each one is cut and pressed at the same time, where the plates are divided into first plates (24) with a first side (25) and a second side (26), where the first plates (24) are being corrugated with a first pattern (27), and
15 second plates (28) with a third side (29) and fourth side (30), where the second plates (28) are being corrugated with a second pattern (31), wherein cells are formed by assembling the first and second plates (24, 28) in pairs with the second side (26) towards the third side (29),.

23. Method for manufacturing a plate heat exchanger (1) device according to
20 claim 22, **characterised in** that the cells (15) are stacked against each other with the first and fourth sides (25, 30) of the plates (24, 28) towards each other.

24. Method for manufacturing a plate heat exchanger (1) device according to
25 claim 23, **characterised in** that the first outlet opening (12) of the cell is made wider than the first inlet opening (11) of the cell.